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THE BLACK-HEADED BUDWORM SURVEY

ON THE TONGASS NATIONAL FOREST, ALASKA

Season of 1954

by

W. F. McCambridge

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SUMMARY

During the summer of 1954, the black-headed budworm[1/] outbreak covered approximately 6,740,000 gross land acres of the Tongass National Forest and Glacier Bay National Monument in Southeast Alaska. The outbreak was situated within the northern portion of the forest, north of Frederick Sound (see map at the end of this report). South of Frederick Sound and in the Yakutat area budworm activity had died out.

Western hemlock suffered heaviest defoliation in the Lynn Canal and Icy Strait areas (north and west of Juneau). Scattered pockets of moderate to heavy defoliation, with some light top killing, were found on Chichagof Island, along the west coast of Baranof Island, and in a few localities on Admiralty Island. In general, budworm feeding in 1954 was much lighter than that which occurred in 1953.

Hemlock forests south of Frederick Sound are recovering after years of defoliation by the budworm. The forests for the most part have taken on a green appearance after an extended period when much of the country reflected a reddish cast. Some large patches of severe hemlock top kill, gray in color, are found at Moira Sound, Cholmondeley Sound, Polk Inlet, Ratz Harbor to Red Bay, all on Prince of Wales Island, and on Wrangell Island and Mitkof Island. Top kill on Admiralty, Baranof and Chichagof Islands cannot be mapped with certainty at this time.

Complete tree kill is negligible. At Juneau in Evergreen Bowl and along the Mt. Roberts trail, some scattered tree kill in young pole-size hemlock may have taken place as a result of budworm feeding. This tree kill is not detrimental to the stand since suppressed hemlock were killed, and a light thinning of the stand produced.

The hemlock sawfly[2/] outbreak south of Frederick Sound has died out. The sawfly continues to accompany the budworm northward, but is light in most areas. Excursion Inlet near Icy Strait contained considerable evidence of sawfly this year and undoubtedly there are other such areas. Defoliation at Excursion Inlet was not considered serious.

1/ *Acleris variana* Fernald

2/ *Neodiprion tsugae*, Middelton

Hemlock twig samples collected at widely distributed locations on the Tongass National Forest were examined for budworm eggs in order to determine the extent and severity of defoliation which could be expected in 1955. These examinations indicate the following:

1. The black-headed budworm outbreak in Southeast Alaska is rapidly drawing to a close. No widespread defoliation of serious magnitude, i.e., heavy enough to cause top kill, is expected in 1955.

2. Some light but noticeable budworm feeding may take place north of Juneau at a few locations scattered throughout the Lynn Canal and in the vicinity of Icy Strait-Glacier Bay.

3. Hemlock forests which suffered heavy defoliation in past years should begin to recover and gradually regain their growth.

INTRODUCTION

Since the fall of 1952, extensive surveys of the black-headed budworm have been carried out under funds made available by the Forest Pest Control Act. The surveys, until this year, have been under the direction of the Division of Forest Insect Investigations of the Bureau of Entomology and Plant Quarantine and have always been closely associated with the Alaska Forest Research Center at Juneau. The Division of Forest Insect Investigations has now been transferred to the Forest Service under the Branch of Research and the 1954 budworm survey was a function of the Alaska Forest Research Center.

As in the past, close cooperation has been maintained with other field personnel of the Forest Service, and with other interested agencies and individuals in the gathering of hemlock twig samples and submission of observation reports.

THE OUTBREAK

History

The outbreak of the black-headed budworm began about 1947, probably in a number of locations throughout the southern half of the Tongass National Forest. The first evidence of budworm feeding was noticed at the mouth of Anan Creek in 1948. By 1950, the infestation was widespread and much in evidence in the Twelve Mile Arm on Prince of Wales Island, and northeast to the Bradfield Canal - a distance of approximately 60 miles. During the summer of 1951, heavy budworm feeding was evident over most of Prince of Wales Island and from Revillagigedo Island to Petersburg. The outbreak extended

across some 140 miles. In 1952 the budworm had become epidemic from the Portland Canal to the Admiralty Lakes region on Admiralty Island - an area encompassing about 11,600,000 acres, and extending across 240 miles.

The budworm outbreak reached its greatest extent in 1953. During that year the budworm was epidemic over the entire Tongass National Forest, an area of 16,073,000 acres. The outbreak extended from the Portland Canal to Yakutat, a distance of about 500 miles. It became evident in 1953 that while the range of the budworm outbreak continued to enlarge, the severity of defoliation was decreasing. Hemlock stands throughout 8,000,000 acres in the areas of previous heavy feeding south of Frederick Sound were suffering only light defoliation. Defoliation north of Frederick Sound to Juneau, and west to the eastern portions of Chichagof and Baranof Islands, was heavy. North of Juneau and at Yakutat defoliation was light.

Present Status

During the summer of 1954, the black-headed budworm was in epidemic proportions from the southern tip of Baranof Island to Skagway (see map at the end of this report). The area of epidemic was approximately 6,740,000 gross land acres. Of this total, about 400,000 acres are within the Glacier Bay National Monument.

Defoliation of western hemlock was very light on the mainland from Frederick Sound north to Juneau. The only area of readily noticeable defoliation, and this on Sitka spruce, was between the mouth of the Taku River and the settlement of Tulsequah in British Columbia.

Heaviest defoliation of hemlock was in the Lynn Canal area and on Chichagof Island in the vicinity of Tenakee Inlet. Moderate feeding and general browning of the hemlock forests extended down the west coast of Chichagof and Baranof Islands, and such feeding was found scattered all over the islands. Defoliation on these islands was not as heavy as occurred in islands throughout the southern portion of the Tongass, and hemlock top kill is not expected to be extensive.

Admiralty Island was heavily infested by budworms in 1952, and to a greater extent in 1953. This year, feeding was generally light, but as yet the forests have been slow in recovering from previous attacks. At Chapin Bay, Chaik Bay, Thayer Lake and other locations, feeding has been heavy, and top kill is common and fairly extensive. However, it will not be possible to determine the extent of top kill until the trees begin to show signs of recovery.

No infestation of the black-headed budworm was found south of Frederick Sound with the exception of a thin band on the west shore of Kuiu Island. At Yakutat, no budworms could be found.

Those forests south of Frederick Sound which suffered heavy defoliation in the past are well on the way to recovery in most instances, and it is now difficult to tell where budworm feeding was heavy just a few years ago. Throughout most of the country where budworm feeding was heavy an occasional dead top on a dominant hemlock tree is all that remains as evidence of the outbreak.

A few of the better stands of hemlock were infested so heavily that the majority of dominant stems suffered top kill. These areas appear gray and are found in patches at Moira Sound, Cholmondeley Sound, Polk Inlet, Ratz Harbor to Red Bay, all on Prince of Wales Island, and on Wrangell Island and Mitkof Island. The aggregate of these areas totals about 10,000 acres.

The only known area where tree killing might be attributed to the budworm is at Juneau. In Evergreen Bowl and along the lower portion of the Mt. Roberts Trail, a few suppressed and intermediate trees have died within the past year. These trees were growing in young pole stands of mixed hemlock and spruce. Death appears to have been brought about by budworm feeding which occurred in 1953. It is quite possible that it was not the severity of budworm attack that killed these trees, but rather that the defoliation provided the light shock which brought about the death of these weakened individuals. When the residual stands recover and come back with full needle complements, it will be difficult to see where damage had occurred. In fact, the removal of a few suppressed and intermediate trees should have a beneficial affect on the remaining trees.

In younger stands which are under study, no complete kill has been found. However, top kill up to 4½ feet has resulted after one year of budworm feeding. This kill has taken place in trees that were approximately 25 feet in height. This condition is typical of the effects of budworm feeding on young open-grown hemlock reproduction. Whether these young trees can recover without deformity remains to be determined.

Trend

The trend of the black-headed budworm continues downward. Defoliation of hemlock in 1955 should be light with perhaps only a few areas of noticeable feeding in the Lynn Canal area, and possibly in the vicinity of Icy Strait-Glacier Bay. This feeding will not be heavy enough to cause top kill of hemlock. These conclusions were reached after a study of the egg count data taken from hemlock twigs collected at areas widely distributed over the Tongass National Forest. These egg count data are presented in Table I which follows. In this table, defoliation is expected to be obvious and associated with off-color foliage only at those locations whose mean eggs per twig inch of needles is greater than .11. Only two locations show a greater egg concentration - Mile 20 and Mile 25 out of Juneau. Should egg parasites or other natural control be active in these areas, defoliation will be substantially reduced.

Table I.-Black-headed budworm egg count data collected from hemlock twig samples cut on the Tongass National Forest - Fall of 1954.

Location	No. of 10" twigs in sample	Twig inches of needles	Eggs	Eggs per twig inch of needles	Date sample collected	Remarks
1 Frederick Cove	30	940*	1	.00	Sept. 15	
2 Johnson Cove	30	940*	0	.00	Sept. 14	
3 Dall Cove	30	940*	0	.00	Sept. 13	
4 Three Lagoons	30	940*	0	.00	Sept. 16	
5 Dolomi Cove	30	940*	0	.00	Sept. 16	
6 Windy Point	—	—	0	.00	Sept. 17	
7 Lencaster Cove	30	940*	0	.00	Sept. 16	
8 West Arm Cholmondeley Sound	30	940*	0	.00	Sept. 17	
9 Ketchikan	30	940*	12	.01	Sept. 21	
10 Dawson Mine	30	940*	0	.00	Oct. 2	
11 Thorne Bay	30	940*	6	.00	Oct. 9	
12 Neets Bay	30	940*	6	.00	Sept. 22	
13 Ratz Harbor	30	940*	0	.00	Oct. 14	
14 Edna Bay	30	940*	17	.02	Sept. 28	
15 French Cove	30	940*	0	.00	Oct. 1	
16 Anan Creek	30	940*	1	.00	Sept. 23	
17 Red Bay	30	940*	2	.00	Sept. 27	
18 Wrangell Narrows	30	940*	2	.00	Sept. 27	
19 Petersburg Dam	30	940*	1	.00	Sept. 24	
20 Petersburg	30	940*	0	.00	Sept. 24	
21 Security Bay	30	850	23	.03	Sept. 27	
22 False Lindenberg Head	30	940*	5	.00	Oct. 5	
23 Fick Cove	30	835	60	.07	Oct. 7	
24 Coffee Cove	30	940*	19	.02	Oct. 5	
25 Salt Lake Bay	30	876	46	.05	Oct. 12	
26 Sea Gull Flats	30	543	54	.10	Oct. 13	
27 Hoonah	30	678	41	.06	Oct. 11	
28 Pt. Howard	30	669	59	.08	Oct. 8	

Table I.-Black-headed budworm egg count data collected from hemlock twig samples cut on the Tongass National Forest - Fall of 1954. (continued)

Location	No. of 10" twigs in sample	Twig inches of needles	Eggs	Eggs per twig inch of needles	Date sample collected	Remarks
29 Douglas - Mile 5	30	633	26	.04	Oct. 6	
30 Douglas	30	940*	14	.01	Oct. 6	
31 Thane	30	897	35	.04	Sept. 29	
32 Evergreen Bowl (hemlock)	75	1410	79	.06	Oct. 13	
32 Evergreen Bowl (spruce)	75	1943	168	.09	Oct. 11,12	
33 Gold Creek	30	940*	12	.01	Sept. 29	
34 Mile 10	27	1000	39	.04	Sept. 30	
35 Mile 5	30	901	48	.05	Sept. 30	
36 Pleasant Island	30	676	48	.07	Oct. 9	
37 Excursion Inlet	30	542	34	.06	Oct. 8	Hemlock sawfly damage common.
38 Mile 15	30	819	45	.05	Oct. 3	
39 Mile 20	30	822	99	.12	Oct. 3	
40 Mile 25	30	485	59	.12	Oct. 3	
41 St. James Bay	30	979	31	.03	Oct. 7	
42 Bridget Cove	30	693	36	.05	Oct. 5	
43 Echo Cove	30	940*	13	.01	Oct. 6	
44 Jamestown Bay (Sitka)	30	728	34	.05	Oct. 14	
45 Skagway (spruce)	29	1416	15	.01	Oct. 4	
46 Eliza Harbor	30	940*	6	.00	Oct. 22	
47 Windfall Harbor	30	892	17	.02	Oct. 23	
48 Taku Harbor	30	940*	15	.02	Nov. 1	
49 Whitewater Bay	30	940*	5	.01	Nov. 11	
50 Hood Bay (South Arm)	30	940*	2	.00	Nov. 12	
51 Hawk Inlet	30	511	40	.08	Nov. 8	

* An average based on 31 samples of 30 twigs each cut in 1953.

During 1954, budworm feeding was observed to be quite noticeable on mountain hemlock growing at timberline. At other locations defoliation on western hemlock was more prevalent at higher elevations than at the lower levels where previous budworm feeding had been heavy. This condition was noticed over widespread areas and was reported by Andersen, LaHaie and Wagstaff. Wagstaff also noticed that egg deposits were heavier at the higher elevations at Hollis. From two samples of thirty twigs each he counted 1 egg on the sea level sample and 28 eggs from a sample taken at 1600 feet.

METHOD OF SURVEY

Aerial mapping of the outbreak and ground sampling activities were interspersed between August 17 and November 12. Aerial mapping of the area north of Frederick Sound was done according to pre-arranged flight paths which were laid out as contour strips in the Lynn Canal and Taku River areas, and as grid lines across Chichagof, Admiralty and Baranof Islands. Ground sampling in these areas followed the aerial mapping.

Aerial mapping and ground sampling were carried out contemporaneously in the vicinity of Petersburg. Aerial coverage of the area was made by contour flying and ground samples were taken at pre-arranged locations along the flight path. This system of survey is very satisfactory, affording welcome physical exertion from the more tedious aerial mapping.

Throughout the southern portion of the Tongass where budworm activity was nil, as determined from the 1953 egg count data and verified by boat travel and commercial flights between Wrangell and Ketchikan and Craig and Ketchikan, all budworm surveying was accomplished by boat travel.

As in previous years, field personnel were requested to collect hemlock twig samples for budworm egg counts. Thirty 10-inch twigs were cut from each sampling location and air-freighted to Juneau where the egg counts were made. When twigs were cut at the outset of extended boat trips, they were kept moist and shipped whenever the opportunity arose. Twigs packed closely in moist burlap remained in good condition for approximately one week.

The egg counts obtained from these twig samples are presented in Table I. On the strength of investigations carried on in 1953 to interpret the significance of data tabulated as eggs per twig inch of needles, the prediction was made that defoliation of hemlock would be obvious and accompanied with discoloration when the mean egg count reached .11 or more eggs per twig inch of needles. During the summer of 1954 those predictions were checked and found accurate with two exceptions.

In September of 1953 an egg count of .53 eggs per twig inch of spruce needles and .21 eggs per twig inch of hemlock needles was obtained at Skagway. Budworm defoliation resulting from such egg counts was expected to be heavy enough to cause general tree browning on both tree species. On June 16 budworm larvae were found in almost every bud, and damage appeared certain. However, by the end of the summer what defoliation did take place at Skagway was hardly noticeable. Why the predicted damage did not occur is not known.

The second exception to the fulfillment of the predicted damage occurred at the Juneau Gold Mine area. The 1953 fall egg count was .29 eggs per twig inch of hemlock needles. In May of 1954, another sample of 30 twigs was cut at this area and a mean of .11 eggs per twig inch of needles was obtained. It is entirely possible that the latter egg count was the most accurate, for defoliation was barely visible.

Part of the discrepancy between the fall and spring egg counts at the Gold Mine area may be due to weathering. However, this discrepancy is not believed to be large.

Four areas were checked to determine if weathering was a factor in egg reduction. The results follow:

Location	Eggs per Twig Inch of Needles	
	Fall 1953	Spring 1954
Juneau - Mile 9.5	.09	.06
Juneau - Mile 12.5	.19	.18
Juneau - Gold Creek	.52	.70
Juneau - Gold Mine	.29	.11

The above egg count means are based on a sample of 30 ten-inch hemlock twigs. These discrepancies and some field observations seem to indicate that 30 ten-inch hemlock twigs is not a highly accurate sample for determining the intensity of budworm eggs at any given area. Nevertheless, as long as the use to which these 30 twigs samples is put and the method of collecting and transporting them do not change, they will be considered practical and satisfactory for determining the spread and relative intensity of the black-headed budworm outbreak.

FACTORS CAUSING OUTBREAK DECLINE

Four natural control factors are important in contributing to the decline of the black-headed budworm outbreak.

Of major importance are parasites and the inability of the budworm to survive. Parasitism varies considerably between areas but

usually the aggregate provides effective reduction of budworm populations. In the Juneau area egg parasitism by Trichogramma minutum, Riley, rose from .9 percent in 1953 to 5 percent in 1954, with some areas containing up to 16 percent egg parasitism. Larval dissections revealed up to 57 percent parasitism in the fifth instar, and 52 percent of the fourth instar. Parasites emerged from up to 25 percent of the budworm pupae. This average is similar to that which occurred in the Juneau area in 1953. As usual, most of the pupal parasites were Itoplectis quadricingulatus, Cush. and Phaeogenes articus, Cush.

The inability of the budworm to survive was again evident this year. Once the eggs hatched, mortality began almost at once. First specific data were taken during the second larval instar. At this time, up to 25 percent of the larvae were dead with no evidence of disease or parasites3/. During the third, fourth and fifth instars, larvae were collected and mortality was observed to approach 25 percent in each instar. From the pupal collections it was found that up to 50 percent of pupae did not produce moths. Evidence of disease or parasites could not be found.

Disease was not evident in the Juneau-Douglas area this year. In 1953 disease killed all of the budworms in certain areas. This year examinations of those same areas and those close by revealed no evidence of disease. A collection of pupae taken at Sitka contained spherical cysts of a protozoan, but since only one collection was possible, specific identification could not be made. In any event, approximately 25 percent of the pupae collected at Sitka exhibited symptoms of being infected by the protozoan.

The fourth factor of considerable importance in the outbreak decline is the mortality suffered by the moths in moving from one area to another. The tremendous numbers of moths which land on ice fields, barren mountain tops, and large bodies of water constitute a substantial loss in outbreak potential.

HEMLOCK SAWFLY

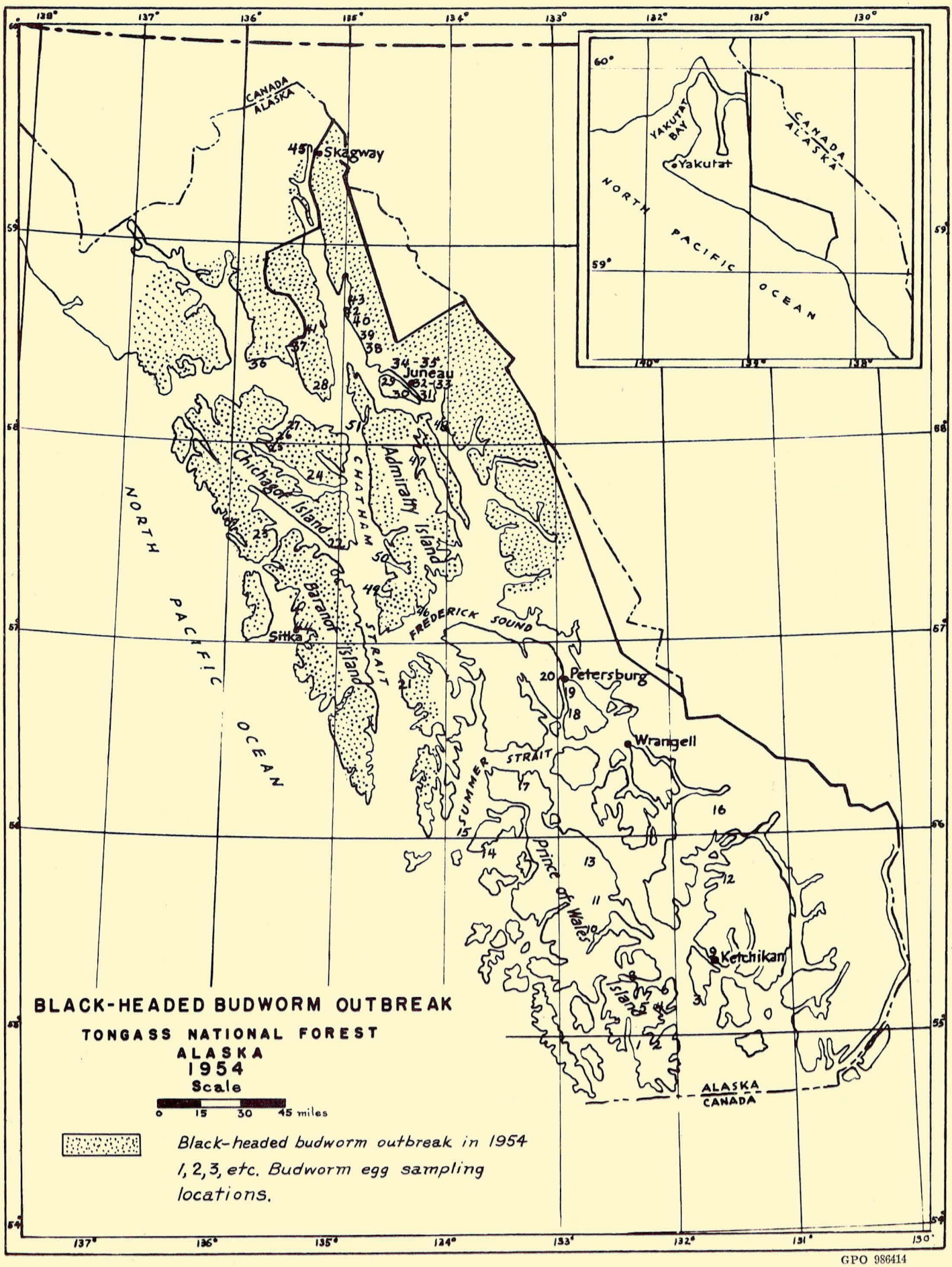
Larvae of the hemlock sawfly were common over much of the area of most recent black-headed budworm infestation, with sawfly damage most prevalent at Excursion Inlet. However, at no location was the sawfly considered epidemic. Sawfly populations in old epidemic areas have dropped to endemic levels. The relative importance of the various control factors was not determined.

3/ Disease investigations were carried on by Dr. E. A. Steinhaus and assistants at the University of California.

RECOMMENDATIONS

1. The black-headed budworm survey should be continued in 1955 to follow the outbreak in its final stages.

2. Hemlock should be examined throughout the northern half of the Tongass National Forest in the spring of 1955 to determine more accurately the extent and intensity of the hemlock sawfly.


BLACK-HEADED BUDWORM OUTBREAK
TONGASS NATIONAL FOREST
ALASKA
1954
Scale
0 15 30 45 miles
Black-headed budworm outbreak in 1954
1, 2, 3, etc. Budworm egg sampling locations.
CANADA
ALASKA
Skagway
Juneau
Yakutat
YAKUTAT BAY
NORTH PACIFIC OCEAN
Chichagof Island
Admiralty Island
Baranof Island
CHATHAM STRAIT
FREDERICK SOUND
Sitka
Petersburg
Wrangell
SUMMER STRAIT
Prince of Wales Island
Ketchikan
ALASKA
CANADA

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